



# The Ohio Department of Transportation Office of Research & Development Executive Summary Report

## Phase II - Improved Work Zone Design Guidelines and Enhanced Model of Travel Delays in Work Zones

*Start Date: September 1, 2005*

*Duration: 43 months*

*Completion Date: May 1, 2009*

*Report Date: March 2009*

*State Job Number: 134270*

*Report Number: FHWA/OH-2009/2*

*Funding: \$339,795*

*Principal Investigators:*

*Helmut T. Zwahlen*

*ODOT Contacts:*

*Technical:*

*David Holstein,  
Reynaldo Stargell,  
Jennifer Gallagher*

*Administrative:*

*Monique R. Evans, P.E.  
Administrator, R&D  
614-728-6048*

*For copies of this final report go to  
<http://www.dot.state.oh.us/divplan/research>  
or call 614-644-8173.*

*Ohio Department of Transportation  
Office of Research & Development  
1980 West Broad Street  
Columbus, OH 43223*

### **Problem**

As stated in "Policy on Traffic Management in Work Zones" ([http://www.dot.state.oh.us/traffic/forms\\_documents/Others/P art%2013%20Policy%20516-003.pdf](http://www.dot.state.oh.us/traffic/forms_documents/Others/P art%2013%20Policy%20516-003.pdf)) Appendix A, the criterion used by ODOT to determine the impact of proposed work zones shall be queue length. The following thresholds shall be used for the evaluation of project queue lengths as determined by the computer model:

1. For queues less than 0.75 miles, the work zone impacts are acceptable.
2. For queues greater than 0.75 miles and less than 1.5 miles, the work zone impacts are acceptable if the queue exceeds 0.75 miles for two hours or less. Where queues are expected to exceed 0.75 miles for any period of time, additional advanced work zone warning signing should be specified.
3. For queues longer than 0.75 miles for more than two hours or longer than 1.5 miles for any period of time, the work zone impacts are unacceptable. Alternate strategies shall be considered per the provisions of this policy.
4. A vehicle will be considered part of a queue if its average operating speed is approximately 10 mph or less. Discretion is required by the District personnel during both the analysis portion and field evaluation of the implemented work zone in determining what constitutes a queue. In general a condition that causes driver frustration due to stop and go operations should be considered a queue.

No computer model to evaluate a complex work zone situation with multiple traffic lanes, lane reductions, and multiple entrance and exit ramps exists at this point in time. Also little information exists about the effect of ramp closings and how the traffic diversion takes place. Further, no comprehensive guidelines about ramp management and ramp metering exist.

### **Objectives**

- The first objective was to develop a digital simulation program which would model work zones on freeways with multiple traffic lanes, lane reductions, and multiple entrance and exit ramps.
- The second objective was to investigate traffic diversions when ramps were closed.
- The third objective was to develop a set of

comprehensive guidelines for ramp management and ramp metering based on the mainline traffic throughput and local traffic access to freeway.

### **Description**

This project contains three major parts. In the first part a digital computer simulation model was developed with the aim to model the traffic through a freeway work zone situation. The model was based on the Arena simulation software and used cumulative interarrival times as the input. Its aim was to determine the traffic volumes through the work zone and the queue lengths in advance of lane restrictions. The program was designed to handle up to 15 miles in length, up to six lanes, and up to 20 entrance and exit ramps. The developed program has not been validated due to the lack of reliable field data and the program appears to produce unreasonably short queue lengths and low exit ramp traffic counts compared to the input traffic data for cases where the exit ramps are spaced closely together.

In the second part a diversion analysis was performed to determine the effects of closed ramps. The work zone sites were assigned by Ohio Department of transportation and the diversion effects for these situations were in one case very minimal and in the other case as expected (traffic shifted to the next open exit ramp).

In the third part guidelines for ramp management and ramp metering were established on a 24/7 basis giving special considerations to freeway mainline throughput and local traffic access to freeway.

### **Conclusions**

At this point in time the use of the Arena simulation program cannot be recommended as a reliable tool to determine queue lengths and correct exit ramp traffic volumes in cases where exit ramps are closely spaced together. Additional field data collection would be required for a more adequate queue length validation and the lane changing mechanisms need to be improved to obtain more correct exit percentage values especially for cases

where multiple lanes and close spacings (less than 1.5 miles apart) between two adjacent exits exist

The work zone sites used in the diversion analysis were assigned by Ohio Department of Transportation. The analysis of the effects of closed ramps on freeway work zone traffic showed that the diversion effects for these situations were in one case very minimal and in the other case as expected (traffic shifted to the next open exit ramp).

Guidelines for temporary entrance ramp control and ramp metering in freeway work zones were developed based on historical hourly traffic volumes for each of the 24 hours of the day and for each of the 7 days of the week to determine the temporary freeway entrance ramp control strategy considering the importance levels of freeway mainline traffic throughput and local traffic access to the freeway through the entrance ramp and the hourly traffic volume levels of the freeway mainline rightmost lane and freeway entrance ramp. These guidelines for temporary entrance ramp control in freeway work zones are comprehensive and will make it possible for traffic engineers to design and implement an entrance ramp control strategy including entrance ramp metering in freeway work zones, which may also be applied to freeways without work zone, and consider both freeway mainline traffic throughput and the local traffic access of the driving public to the freeway system.

### **Recommendations**

The use of Arena simulation program is not recommended as a tool for queue length analysis due to lack of reliable field data for validation.

ODOT must improve the availability of hourly traffic volumes for Saturday and Sunday in addition to the available hourly traffic volumes for weekdays (Monday-Friday, [http://www.dot.state.oh.us/Divisions/Planning/TechServ/Prod\\_Services/Pages/default.aspx](http://www.dot.state.oh.us/Divisions/Planning/TechServ/Prod_Services/Pages/default.aspx)) in order to implement a 24/7 ramp management and ramp metering approach.

### **Implementation Potential**

The implementation potential of the guidelines for ramp management and ramp metering on a 24/7 basis is high and should be implemented as soon as possible. Such an implementation will however require more of a planning effort, a timing computer to specify the hourly ramp management and ramp metering strategy for 7 days and additional signs, signals, and possibly changeable message signs in some cases. On the other hand these guidelines should maximize the local access to the freeway during the whole week while at the same time maximize the mainline throughput.